

## COPYING SYSTEM

BACKGROUND OF THE INVENTION1. Field of Invention

The invention relates to a copying system including a host device, such as a personal computer, and a peripheral device connected to each other. Specially, the invention relates to a copying system capable of performing a copying processing for a color original document within a short time, even when the available memory in the peripheral device is limited.

2. Description of Related Art

As shown in a block diagram of Fig. 10, a copying system is conventionally comprised of a multi-function center (hereinafter referred to as MFC) 100 and a personal computer 200 (hereinafter referred to as PC), as a host device connected to each other.

Color images on an original document are read by a scanner 101 of the MFC 100 as analog data of three colors red, green, and blue. Hereinafter, red, green, and blue are referred to as "R", "G", and "B", respectively. The analog RGB data is converted by a control circuit 102 into multi-value 8-bit digital RGB data, and is transmitted to the PC 200 (104). The multi-value RGB data transmitted to the PC 200 is received via a TWAIN driver 201. Thereafter, the multi-value RGB data is subjected to a color matching processing 202, and is output to a color copying application 203. The multi-value RGB data underwent the color matching processing 202 and output to the color copying application 203, is then output to a printer driver 204, as the copying designation by an operator. Further, the multi-value RGB data is converted by the printer driver 204 into 1-bit binary data of four colors of cyan, magenta, yellow, and black, that can be printed in a printer 103 of the MFC 100. Hereinafter, cyan, magenta, yellow, and black are referred to as "C", "M", "Y", and "K", respectively. The binary CMYK data is then transmitted to the MFC 100 (205). The binary CMYK data transmitted to the MFC 100 is output from the control circuit 102 to the printer 103. The printer 103 performs color printing. Fig. 11 shows a manner when three copies of a total of two pages of original documents are produced in the sort copying mode, according to the designation by an operator.

The amount of image data of a color original document is large. For example, the amount of the image data for a A4-sized color original document will be

approximately 10 Mbyte. A peripheral device of the MFC 100 has a memory therein whose size is not so large that the available memory will be limited. The PC 200 usually has a large-capacity memory. Therefore, by constructing the above-described color copying system in the following manner, the color copying processing can be smoothly performed. The color image/data obtained by reading a color original document by the scanner 101 of the MFC 100 is transmitted to the PC 200 and is temporarily stored therein. The data is sorted in the PC 200, and is then sent back to the MFC 100. The data sent back from the PC 200 is printed in color by the printer 103 of the MFC 100. With the above-described construction, the color copying processing for the color original document with the large amount of image data, can be smoothly performed in the MFC 100, via the PC 200, by using the memory in the PC 200, even though the memory size in the MFC 100 is limited.

However, in the above-described color copying system, the multi-value RGB data has to undergo the color matching processing 202 and then has to be converted into the binary CMYK data by the printer driver 204 in the PC 200. These steps lead to the longer color copying processing time. In addition, the multi-value RGB data is larger in size, as compared with the binary CMYK data. Therefore, it takes time to send such large multi-value RGB data in size from the MFC 100 to the PC 200.

The color matching processing 202 is a collection processing performed for the multi-value RGB data on a pixel basis according to a display driver of the PC 200, to show the images on a display in the PC 200. The color matching processing 202 requires a relatively long time, though this is unnecessary for color printing. That is, the color matching processing 202 is not needed in the case where an operator does not require the indication of the images on the display but requires the color copy thereof. To the contrary, the conversion of the multi-value RGB data into the binary CYMK data is necessary for color printing, and is performed by the printer driver 204 as described above. However, as shown in Fig. 11, the printer driver 204 has to convert the multi-value RGB data into the binary CMYK data for the total of six pages (2 pages X 3 copies), even though the original document is only two pages, as the operator designates the three copies of a total of two pages of the original documents. This also leads to the longer color copying processing time.

### SUMMARY OF THE INVENTION

One aspect of the invention is to provides a copying system that can perform color copying processing for a color original document within a short time.

5 The color copying system of the invention may include a host device and a peripheral device connected to the host device and having a printing device. The peripheral device may include a reading device that reads an image on an original document as image data, a converting device that converts the image data read by the reading device into printable data that can be printed by the printing device, a first transmission device that transmits to the host device the printable data converted by the converting device, and a reception printing device that receives the printable data from the host device and causes the printing device to print the printable data. The host device may include a storage device that stores various data, a reception control device that receives the printable data transmitted from the first transmission device and stores the printable data in the storage device, and a second transmission device that transmits to the peripheral device the printable data stored in the storage device by the reception control device.

15 In the copying system, the image on the original document is read by the reading device, as the image data. The image data is converted by the converting device, into the printable data that can be printed by the printing device. Thereafter, the printable data is transmitted by the first transmission device, from the peripheral device to the host device. The data transmitted by the first transmission device, is received by the reception control device and temporarily stored in the storage device. The data stored in the storage device, is transmitted by the second transmission device, from the host device to the peripheral device. The data is received by the reception printing device and output to the printing device. Then, the data is printed by the printing device.

### BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will be described in detail with reference to the following figures, wherein:

30 Fig. 1 is a perspective view of a color copying system including a multi-function center (MFC) and a personal computer (PC), according to an embodiment of the invention;

Fig. 2 is a block diagram illustrating the electrical arrangement of the color copying system;

Fig. 3 is a block diagram briefly illustrating the image data processing by an application-specific integrated circuit (ASIC) of the MFC;

5 Fig. 4 is a block diagram briefly illustrating an operation of the color copying system;

Fig. 5 is a block diagram illustrating data input to/output from a color copying application;

Fig. 6 is a flowchart illustrating a reading task executed by the MFC;

10 Fig. 7 is a flowchart illustrating one of color copying processing executed by the color copying application in the PC;

Fig. 8 is a flowchart illustrating a printing task executed by the MFC;

Fig. 9 is a flowchart illustrating one of the color copying processing executed by the color copying application in the PC;

15 Fig. 10 is a block diagram briefly illustrating an operation of a color copying system in the prior art; and

Fig. 11 is a block diagram briefly illustrating an image data processing in the PC in the prior art.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

20 Preferred embodiments of the invention will be described in detail with reference to Figs. 1-8. A color copying system 80 according to an embodiment, includes a multi-function center (hereinafter referred to as the MFC) 1 and a personal computer 50 (hereinafter referred to as the PC) connected to each other. The MFC 1 is a peripheral device having a plurality of functions, for example, a scanner function,  
25 a printer function, a copying function, a modem function, and a facsimile function.

Fig. 1 shows the perspective view of the color copying system 80. The MFC 1 is provided with a handset 3 at a side of the body housing 2. The handset 3 is placed on a hook (not shown) provided on the body housing 2 when a telephone conversation is not made, and the handset 3 is picked up and off the hook during a telephone  
30 conversation. The former is called an "on-hook" condition. The latter is called an "off-hook" condition.

Provided on an upper front portion of the body housing 2 is a control panel 4 having a plurality of keys 4a. At the left-end portion of the control panel 4, a liquid

crystal display (LCD) 5 is provided. The keys 4a are pressed down for the MFC 1 to perform operations. The LCD 5 shows, for example, operation conditions of the MFC 1 and operation procedures.

An original document insertion opening 6 is provided at the rearward portion of the control panel 4 and the LCD 5. An original document is inserted facing down into the original document insertion opening 6, when facsimile data of the original document is transmitted to another facsimile apparatus or the original document is copied. The original document inserted into the original document insertion opening 6, is read by a scanner 22 (see Fig. 2), as image data. Thereafter, the original document is discharged from an original document discharge opening 7 provided on the front face of the body housing 2 below the control panel 4. At the rearward portion of the original document insertion opening 6, a sheet holder mounting portion 9 is provided. To the sheet holder mounting portion 9, a sheet holder 10 capable of holding a stack of recording sheets, is removably set. The recording sheet supplied from the sheet holder 10 and subjected to printing by a printer 25 (see Fig. 2), is discharged from a recording sheet discharge opening 8 disposed below the original document discharge opening 7.

Provided on the back of the body housing 2 is a connector (not shown) for a PC interface 35 as a port. The MFC 1 is connected to the PC 50, via a cable 36 connected to the PC interface 35. The MFC 1 and the PC 50 may be connected not via the cable 36 but an optical signal of, for example, infrared rays.

Fig. 2 is a block diagram illustrating the electrical arrangement of the color copying system 80. The MFC 1 includes the following components: a central processing unit (CPU) 11; a read-only memory (ROM) 12; an electrically erasable programmable read-only memory (EEPROM) 13; a random-access memory (RAM) 14; an image memory 15; a voice memory 16; an application-specific integrated circuit (ASIC) 18; a PC interface 35; a voice LSI 17; a network control unit (NCU) 19; a modem 20; a buffer 21; a scanner 22; an encoder 23; a decoder 24; a printer 25; a control panel 4; a liquid crystal display (LCD) 5; and an amplifier 27. These components are connected to each other via a bus line 30.

The NCU 19 performs the network controls. The MFC 1 is connected to a telephone line 31, via the NCU 19. The NCU 19 receives various signals, for example, a ringing signal transmitted from a switchboard 29. The NCU 19 also

The CPU 11 executes the various operations, for example, scanning, printing, copying, and facsimile operations, based on control programs stored in the ROM 12 by controlling the relevant components connected by the bus line 30. The ROM 12 is a non-rewritable memory that stores the control programs executed by the MFC 1. The tasks shown in the flowcharts in Figs. 6-8 are performed based on the programs stored in the ROM 12. The EEPROM 13 is a non-volatile rewritable memory, so data stored therein is not lost even if the MFC 1 is power down. The RAM 14 is a volatile rewritable memory. The RAM 14 temporarily stores the various data when the MFC 1 executes an operation.

The image memory 15 is a memory for storing communication records, image data, and a bit image for printing. For the image memory 15, a large-capacity and low-priced dynamic RAM (DRAM) is used. The image memory 15 stores the image data obtained by reading an original document by the scanner 22, the image data of a received facsimile, and print data transmitted from the PC 50. The voice memory 16 stores a response message sent out to a receiver-side apparatus and an incoming message from the receiver-side apparatus, via the telephone lines 31, 32. Similar to the image memory 15, a large-capacity and low-priced dynamic RAM (DRAM) is used for the voice memory 16. The incoming message stored in the voice memory 16 is erased therefrom by an erasing operation performed via the control panel 4, or by receiving an erase command sent from the other apparatus connected to the telephone lines 31, 32.

The voice LSI 17 performs a voice recognition processing to convert an analog voice signal received by the NCU 19, into a digital voice signal, and a voice synthesis processing to convert the digital voice signal generated in the MFC 1, into the analog voice signal and to output to the NCU 19 or the speaker 28 (amplifier 27).

The PC interface 35 is a parallel interface of, for example, the Centronics type. The MFC 1 is connected to the PC 50 by the cable 36 connected to the PC interface 35. The MFC 1 transmits to and receives from the PC 50 the image data or various commands, via the cable 36.

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5           The RAM 53 temporarily includes a repetition counter 53a, an original document page counter 53b, and a print page counter 53c when the color copying processing (Fig. 7) is executed by the color copying application 57a stored in the HD 57. The counters 53a, 53b, 53c are used by the color copying application 57a.

The original document page counter 53b is a counter for storing the number of original documents to be copied. The initial value for the original document page counter 53b is set to zero (0) (S22). Every time one page of the image data is received from the MFC 1, one (1) is added to the value in the counter 53b (S25). The print page counter 53c is a counter that counts the number of printed pages. The image (print) data transmitted to the MFC 1 from the PC 50 is printed by the printer 25 of the MFC 1. Therefore, the number of pages of the image (print) data transmitted from the PC 50 to the MFC 1 is counted as the number of the printed/recorded pages.

The HD 57 is a large-capacity rewritable memory for storing an operating system (OS) of the PC 50 and various application programs. The image data transmitted from the MFC 1 to the PC 50, is temporarily stored in the HD 57. Generally, the amount of the color image data is large. For example, the amount of the image data for a A4-sized color original document will be approximately 10 Mbyte. The image memory 15 of the MFC 1 can store only the color image data of

approximately two pages of the A4-sized original documents. Therefore, in the color copying system 80, the image data is temporarily stored in the HD 57 of the PC 50 when the color copying processing is performed. In addition to the image data, which are temporarily stored in the HD 57, the color copying application 57a that executes the color copying processing shown in Fig. 7, is also stored therein.

The FDD 58 is a drive for reading programs and data stored in a floppy disk installed in the FDD 58 or for writing a program or data in the floppy disk.

With reference to Fig. 4, the functions of the above-constructed color copying system 80 will be briefly described. In the color copying system 80, images on a color original document are read by the scanner 22 of the MFC 1, as analog RGB data. The analog RGB data is converted into digital binary CMYK data by the ASIC 18. The converted digital binary CMYK data is transmitted to the PC 50 (41). The binary CMYK data is image data that can be printed by the printer 25, so that the binary CMYK data does not have to be converted in the PC 50. Therefore, when the binary CMYK data for all pages of the original documents is received by the color copying application 57a of the PC 50, the binary CMYK data is then sequentially transmitted to the MFC 1 in the order of printing by the printer 25 of the MFC 1, according to the copying designation by the operator (42). Fig. 5 shows the operation manner of the color copying application 57a when three copies of total of two pages of original documents are copied in a sort copying mode.

The color copying system 80 does not require the color matching processing 202 (Fig. 10) that is conventionally performed in the PC 50. In addition, the conversion of the multi-value RGB data into the binary CMYK data, is conventionally performed for all pages of the copies to be produced (see Fig. 11), however, such conversion is performed only for the number of original documents by the ASIC 18. By the use of an integrated circuit of the ASIC 18 specifically designed for the MFC 1, the conversion of the multi-value RGB data into the binary CMYK data, can be performed speedily and accurately. Accordingly, the color copying system 80 of the embodiment speedily and accurately performs the copying processing for a color original document, regardless of the memory capacity in the MFC 1, so that high image quality outputs of copy images (print results) can be obtained within a short time.

Generally, two copying modes can be used when a plurality of copies of an original document are produced in the multi-copying processing: stack copying mode and sort copying mode.

For example, when three (3) copies of one page each of the original documents A and B (total of 2 pages) are designated and copied using the stack copying mode, images read from the original A are consecutively duplicated on three sheets of the recording paper. Then, images read from the original document B are consecutively duplicated on three sheets of the recording paper. In other words, in the stack copying mode, images on an original document are consecutively duplicated on the required number of recording paper to produce the designated number of copies. On the other hand, when three (3) copies of one page each of the original documents A and B (total of 2 pages) are designated and copied using the sort copying mode, for example, images read from the original document A are duplicated on one sheet of the recording paper. While the image data of the original document A is stored in a memory, images read from the next original document B are duplicated on another sheet of the recording paper. Thus, one copy of the original documents A and B is produced. Thereafter, the other one (1) copy is produced in the same manner as described above, based on the stored image data of the original documents A and B.

In this embodiment, the color copying processes that the color copying system 80 performs, for example, in the sort copy mode will be explained below, with reference to the flowcharts shown in Figs. 6-8. Fig. 6 is a flowchart illustrating a reading task executed by the MFC 1. In the reading task, the CPU 11 first determines that an original document is set into the original document insertion opening 6 (S1). The CPU 11 repeats step S1 until the original document is set thereinto. When the original document is set into the original document insertion opening 6 (S1: YES), the CPU 11 repeats step S2 until an operator designates a PC copy where color copying is performed via the PC 50. The PC copy may be designated by the operator, via the control panel 4 of the MFC 1 or the PC 50 as described above. The copying mode, such as the sort copying mode and the stack copying mode, and the number of copies, are also designated at the time when the PC copy is designated. In this embodiment, three (3) copies are produced in the sort copying mode (the copying mode is the sort copying mode, and the number of copies is three (3)).



Fig. 7 is a flowchart illustrating color copying processing executed by the color copying application 57a stored in the HD 57 of the PC 50. The color copying processing, such as shown in Fig. 7, starts when the PC 50 receives from the MFC 1 the PC copy start data and the data for the copying mode in which the sort copying mode is designated.

5 In the color copying processing, the PC 50 first receives the data for the number of copies (3) from the MFC 1. The CPU 51 writes the value (3) for the number of copies into the repetition counter 53a (S21). The CPU 51 initializes the original document page counter 53b by clearing the value in the counter 53b to zero (S22). Then, the CPU 51 repeats step S23 until one page of the image data (binary  
10 CMYK data) is received. When one page of the image data is received (S23: YES), the CPU 51 stores the one page of the image data in the HD 57 (S24), and adds one (1) to the value in the original document page counter 53b (S25). Then, the CPU 51 determines whether the PC copy reading finish data transmitted from the MFC 1, is received (S26). If the PC copy reading finish data has not yet been received (S26:  
15 NO), the image data for one or more pages exists. Therefore, the CPU 51 repeats steps S23 to S25 for the existing image data. In this embodiment, since the total number of the original documents are two pages, the value in the original document page counter 53b is finally added up to two (2).

Upon the reception of the PC copy reading finish data (S26: YES), the image  
20 data (binary CMYK data) for all of the original documents have been received. Thereafter, the CPU 51 executes a processing to transmit the received image data to the MFC 1 in the order of printing, according to the operator's designation. First, the CPU 51 writes one (1) into the print page counter 53c (S27). Then, the CPU 51 reads from the HD 57 the image data (binary CMYK data) for the "n"th page indicated by  
25 the value "n" in the print page counter 53c, and transmits the image data to the MFC 1 (S28). In this case, one (1) is written into the print page counter 53c, so that the first page of the image data is read from the HD 57 and transmitted to the MFC 1. The image data transmitted to the MFC 1 is printed by the printer 25 of the MFC 1.

The CPU 51 repeats the image data transmission until the one page of the  
30 image data is completely transmitted (S29: NO). When the CPU 51 completely transmits one page of the image data (S29: YES), the CPU 51 determines whether the value in the print page counter 53c and that in the original document page counter 53b are equal (S30). In this case, the value in the print page counter 53c is one (1) and that

5 In S30, when the value in the print page counter 53c and that in the original document page counter 53b are equal (when the values in the counters 53c and 53b are two (2)) (S30: YES), the image data for all original documents, that is, the image data for the first and the second pages of the original documents, is transmitted to the MFC 1. Therefore, the CPU 51 subtracts 1 from the value in the repetition counter 53a storing the value for the number of copies (S32). In this case, subtracting 1 from 3, the value in the repetition counter 53a reads 2.

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CPU 11 discharges the printed sheet from the print sheet discharge opening 8 (S45). Then, the CPU 11 repeats step S41 until new image data is transmitted from the PC 50.

In this embodiment, a first transmission device corresponds to step S7 in Fig. 6. A reception control device corresponds to step S24 in Fig. 7. A second transmission device corresponds to step S28 in Fig. 7. A reception printing device corresponds to step S43 in Fig. 8. A sorting device corresponds to steps S27 to S33 in Fig. 7.

While the invention has been described with reference to the embodiments, it is to be understood that the invention is not restricted to the particular forms shown in the foregoing embodiments. Various modifications and alterations can be made thereto without departing from the scope of the invention.

For example, in the above-described embodiment, the MFC 1 converts by the ASIC 18 the analog RGB data read by the CIS 22a, into the binary CMYK data, and then, transmits the binary CMYK data to the PC 50. However, the analog RGB data read by the CIS 22a may be converted by the ASIC 18, into multi-value CMYK data, and the multi-value CMYK data may be transmitted to the PC 50. In this case, the pseudo-half-tone processing by error diffusion 18i shown in Fig. 3 needs to be replaced with a multi-value error diffusion processing. Consequently, the ASIC 18 needs to include the circuits for the multi-value error diffusion processing. In Figs. 4 and 5, the multi-value CMYK data is transmitted from the MFC 1 to the PC 50 and from the PC 50 to the MFC 1.

For example, although the foregoing embodiment employs an ink-jet color printer 25 as a printing device, the invention may also be applied to other types of printers, for example, a color laser printer or other types of color printers. Further, in the foregoing embodiment, a plurality of original documents are duplicated for example, in the sort copying mode where sets of copies of the original documents are produced. However, the invention may be applied if the original documents are duplicated in the stack copying mode where the designated number of copies are consecutively produced for each page of the original documents in the order of the pages in the original documents.

Fig. 9 is a flowchart illustrating one of color copying processing executed by the color copying application 57a stored in the HD 57 of the PC 50. The color copying, such as

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shown in Fig. 9, starts when the PC 50 receives from the MFC 1 the PC copy start data and the data for the copying mode in which the stack copying mode is designated. In this embodiment, three (3) copies of total of two (2) pages of original documents are produced in the stack copying mode.

5           In the color copying processing, the PC 50 first receives the data for the number of copies (3) from the MFC 1. The CPU 51 writes the value (3) for the number of copies into the repetition counter 53a (S51). The CPU 51 initializes the original document page counter 53b and the print page counter 53c by clearing the values in the counters 53b and 53c to zero (S52). Then, the CPU 51 repeats step S53  
10           until one page of the image data (binary CMYK data) is received. When one page of the image data is received (S53: YES), the CPU 51 stores the one page of the image data in the HD 57 (S54), and adds one (1) to the value of the original document page counter 53b (S55). Then, the CPU 51 determines whether the PC copy reading finish data transmitted from the MFC 1, is received (S56). If the PC copy reading finish  
15           data has not yet been received (S56: NO), the image data for one or more pages exists. Therefore, the CPU 51 repeats steps S53 to S55 for the existing image data. In this embodiment, since the total number of the original documents are two pages, the value in the original document page counter 53b is finally added up to two (2).

          Upon the reception of the PC copy reading finish data (S56: YES), the image  
20           data (binary CMYK data) for all of the original documents (two pages) have been received. Thereafter, the CPU 51 executes a processing to transmit the received image data to the MFC 1 in the order of printing, according to the operator's designation. First, the CPU 51 writes one (1) into the print page counter 53c (S57). Then, the CPU 51 compares the value (2) in the original document page counter 53b  
25           with the value (1) in the print page counter 53c (S58). At this time, the value in the original document page counter 53b is larger than that in the print page counter 53c (S58: NO). Therefore, the CPU 51 reads from the HD 57 the image data (binary CMYK data) for the "n"th page indicated by the value "n" in the print page counter 53c, and transmits the image data to the MFC 1 (S59). In this case, one (1) is  
30           written into the print page counter 53c, so that the first page of the image data is read from the HD 57 and transmitted to the MFC 1. The image data transmitted to the MFC 1 is printed by the printer 25 of the MFC 1.

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The CPU 51 repeats the image data transmission until the one page of the image data is completely transmitted (S60: NO). When the CPU 51 completely transmits one page of the image data (S60: YES), the CPU 51 subtracts 1 from the value in the repetition counter 53a storing the value for the number of copies (S61).

5 In this embodiment, one (1) is subtracted from the value 3 in the repetition counter 53a, so that the value in the counter 53a becomes two (2). Since the value in the repetition counter 53a is not zero (0) (S62: NO), the image data for all the designated number of copies, has not yet been transmitted to the MFC 1. Therefore, the CPU 51 repeats steps S59 to S61 until the value in the repetition counter 53a  
10 becomes zero (0).

In step S62, when the value in the repetition counter 53a is zero (0) (S62: YES), the image data of the first page for three (3) copies as designated by the operator, has been transmitted to the MFC 1. Then, the CPU 51 writes the value (3) for the number of copies into the repetition counter 53a, for the next page of the  
15 original documents (S63), as similar to step S51. The CPU 51 also adds one (1) to the value in the print page counter 53c (S57). The value "n" in the print page counter 53c indicates that the image data (binary CMYK data) for the "n"th page of the original documents, is to be transmitted from the PC 50 to the MFC 1. For example, when the value in the print page counter 53c becomes 2 from 1, the image data for the second  
20 page of the original document is to be transmitted from the PC 50 to the MFC 1.

Then, the CPU 51 compares the value in the original document page counter 53b with that in the print page counter 53c (S58). At this time, the value (2) in the original document page counter 53b is equal to the value (2) in the print page counter 53c (S58: NO). Therefore, the CPU 51 reads from the HD 57 the image data  
25 (binary CMYK data) for the second page, as indicated by the value 2 in the print page counter 53c, and transmits the image data to the MFC 1 (S59).

The CPU 51 repeats the steps S59 to S61 until the value in the repetition counter 53a becomes zero (0). Thereafter, the CPU 51 compares the value (2) in the original document page counter 53b with the value (3) in the print page counter 53c  
30 (S58). At this time, the value (2) in the original document page counter 53b is smaller than the value (3) in the print page counter 53c (S58: YES), so that the image data of all the original documents for the designated number of copies, have been transmitted

from the PC 50 to the MFC 1. Therefore, the CPU 51 erases the image data stored in the HD 57 in step S54 (S64), whereupon the color copying processing ends.

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